

CHAPTER 3

DISTRIBUTION MAINS

3-1. Main sizes. Water distribution mains of various materials are readily available in sizes ranging from 6 to 48 inches inside diameter; large pipes up to 144 inches and greater can be specially made. Minimum diameter for distribution mains is 6 inches.

a. Domestic requirements. The system should be capable of delivering the peak domestic demand as described in EM 1110-3-160, plus any special requirements, at pressures not lower than 30 psi at ground elevation. The required daily demands should be determined by calculating the effective populations of various area to be served and applying the appropriate per capita water allowances (EM 1110-3-160).

b. Fire flows. The distribution system will be designed to deliver the necessary fire flow requirements, the required daily demand, and any industrial or special demands which cannot be reduced during a fire. When only hose streams are supplying the required fire flow streams, residual ground level water pressures at fire hydrants should be not less than 10 psi. If sprinkler systems are used, residual pressures adequate for proper operation of the sprinkler systems must be maintained. Specific guidance as to fire flows and pressure required for various structures and types of fire protection systems is given in EM 1110-3-166.

c. Friction losses. In computing head losses due to friction in a distribution system, the Hazen-Williams formula, equation 3-1, will be used.

$$V = 1.318 CR^{0.63}S^{0.54} \quad (\text{eq 3-1})$$

or, $Q = 193.98 CD^{2.63}S^{0.54}$ for circular pipe flowing full.

where:

V = the mean velocity of the flow, in fps.

Q = the discharge in gpm.

R = the hydraulic radius of the pipe in feet, i.e., the cross-sectional area of a flow divided by the wetted perimeter of the pipe. For a circular pipe flowing full, the hydraulic radius is equal to one-fourth the pipe diameter.

S = the friction head loss per unit length of pipe (feet per foot).

D = pipe diameter, in feet.

C = a roughness coefficient, values of which depend on the type and condition of pipe.

Unless otherwise determined, hydraulic analyses for mobilization will be made using a C value of 130.

d. Main size calculations. The velocity in distribution mains should be between 5 and 10 fps. A lower velocity indicates the pipe could be over-sized, leading to added pipe costs and sediment problems; a higher velocity implies added head loss adversely affecting flow capability and residual pressures. The velocity is determined by dividing the peak domestic flow by the cross-sectional area of the pipe selected. If the velocity falls within the given range, the pipe size is acceptable. Slight variations outside this range are permissible for situations peculiar to a particular design. The pipe diameter thus selected can be used in equation 3-1 to determine S. The total length of pipe is multiplied by S to give the total head loss for this pipe. This head loss is used to calculate the pressure drop along the pipe. The analysis is relatively simple for a single pipe. For more complex networks, procedures such as the Equivalent Pipe method, the Alternative Equivalent Pipe method, and the Hardy Cross method as demonstrated in appendix A, should be used.

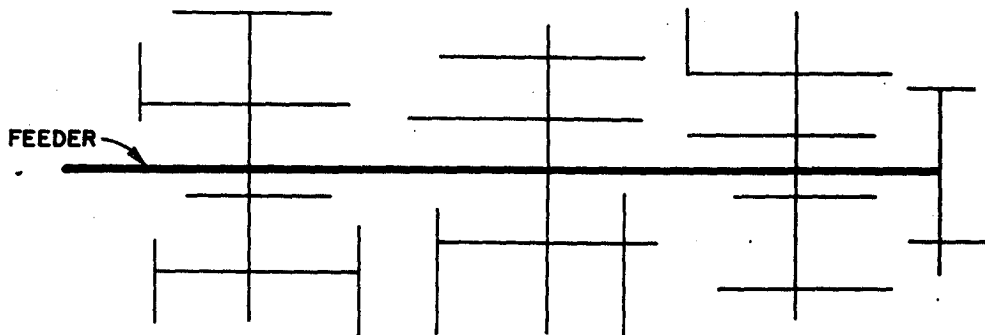
e. Fire-hydrant branches. Fire-hydrant branches (from main to hydrant) should not be less than 6 inches in diameter and as short in length as possible, preferably not longer than 50 feet with a maximum of 300 feet.

3-2. Location of mains.

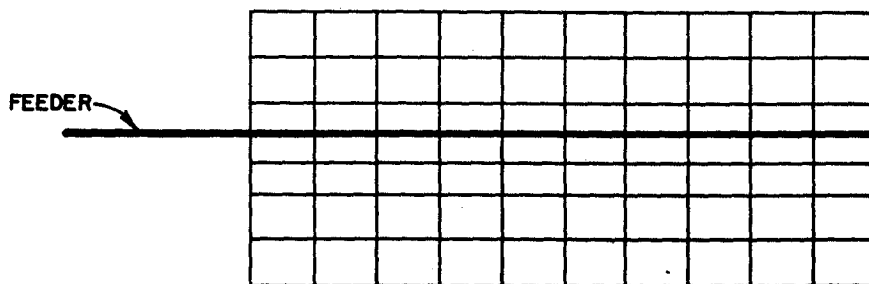
a. General. Mains should be located along streets in order to provide short hydrant branches and service connections. Mains should not be located under paved or heavily traveled areas and should be separated from other utilities to insure that the safety of potable water supplies will be maintained and that maintenance of a utility will cause a minimum of interference with other utilities.

b. Distribution system configuration. The configuration of the distribution system is determined primarily by size and location of water demands, street patterns, location of treatment and storage facilities, and topography. Two patterns of distribution main systems commonly used are the branching or dead end and gridiron patterns.

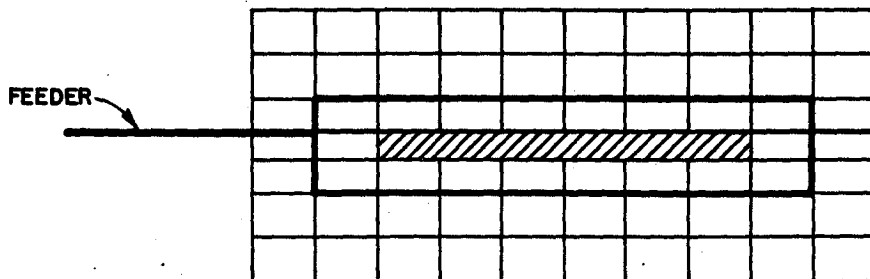
(1) Branching system. The branching system shown in figure 3-1(A), evolves if distribution mains are extended along streets as the service area expands. A branching system can be constructed faster and with less materials than the gridiron system but does not have its reliability. Dead ends in the distribution system are usually undesirable and should be avoided to the extent possible. Fittings and plugs should be provided where possible so that branched systems can be converted to looped systems as the need arises during the service period.



(A) BRANCHING OR DEAD-END PATTERN



(B) GRIDIRON PATTERN WITH CENTRAL FEEDER



(C) GRIDIRON PATTERN WITH LOOPED FEEDER
(AREA OF HIGHEST DEMAND CROSS-HATCHED)

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FIGURE 3-1. WATER DISTRIBUTION SYSTEM PATTERNS

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(2) Gridiron system. The second distribution configuration is the gridiron pattern shown in figure 3-1(B) and (C). The gridiron system has the hydraulic advantage of delivering water to any location from more than one direction, thereby avoiding dead ends. The use of a gridiron looped feeder system is preferable to the use of a gridiron pattern with a central feeder system because the looped feeder supplies water to the area of greatest demand from at least two directions. A looped feeder system is to be used for distribution systems whenever practicable. Although it is advantageous to have all water users located within a grid system, it is often impractical to do so. Water is generally delivered to a remote water user, or a small group of users, by a single distribution main. Therefore, the majority of the water users are served within a gridiron system, while the outlying water users are served by mains branching away from the gridiron system. Branching mains should be avoided to the extent possible.

c. Horizontal separation between water mains and sewers. Water mains should be laid horizontally, a minimum of 10 feet, from any point of existing or proposed sewer or drain line. Water mains and sewers must not be installed in the same trench. If any conditions prevent a horizontal separation of 10 feet, a minimum horizontal spacing of 6 feet can be allowed, but the bottom of the water main must be at least 12 inches above the top of the sewer. Where water mains and sewers follow the same roadway, they will be installed on opposite sides of the roadway, if practicable.

d. Water main sewer crossings. Where water pipes and sewers must cross, the sewer will have no joint within 3 feet of the water main unless the sewer is encased in concrete for a distance of at least 10 feet each side of the crossing. If special conditions dictate that a water main be laid under a gravity-flow sewer, the sewer pipe should be fully encased in concrete for a distance of 10 feet each side of the crossing, or should be made of pressure pipe with no joint located within 3 feet horizontally of the water main, as measured perpendicular to the water main. Pressure sewer pipe should always cross beneath water pipe, and a minimum vertical distance of 2 feet between the bottom of water pipe and the top of pressure sewer pipe should be maintained. The sewer must be adequately supported to prevent settling.

e. Protection in airfield pavement areas. Water mains should not be located under airfield pavement areas if other locations are available. Special protection of the mains is required when alternative locations are not available and it is necessary to locate water mains under pavement areas on which aircraft move under their own power. The amount of protection needed is dependent upon the importance of maintaining a supply of water to the area served by the main and on the availability of emergency water supplies to the affected area. The degrees of protection should be considered as follows:

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(1) Minimum protection. The water main must be enclosed in a vented, open-end, outer conduit from which the main can be removed for repairs or replacement. The outer conduit must have sufficient strength to support all foreseeable loadings.

(2) Intermediate protection. Intermediate protection requires the water service to be carried under the airfield pavement by dual waterlines enclosed in an outer conduit or, preferably, in separate conduits.

(3) Maximum protection. Where more than one utility crosses the airfield pavement and individual crossings would be more expensive than a combined crossing, the utilities will be enclosed in a utility tunnel of sufficient size for in-place repairs. Special precautions must be taken in the placement and protection of individual utility lines within the tunnel to insure that failure of one utility does not affect the service of the others. Special protection of mains is not required where the mains are located beneath pavement areas that are not normally subject to the movement of aircraft under their own power, such as hangar access aprons on which aircraft would be towed.